CLAIMS

1. A chemical reaction system for performing chemical reactions of a target substance comprising a chemical reaction part which is composed of an oxygen ion conductor (ion conduction phase) and two electrodes, a corresponding cathode (reduction phase) and anode (oxidation phase) with the ion conduction phase therebetween, as basic units, wherein micro reaction regions where oxidation-reduction reactions of a target substance take place are introduced into part of the chemical reaction part by applying current, voltage, or heat treatment in a reducing atmosphere or under reduced pressure to the points of contact between the ion conduction phase and an electron conduction phase, which is composed of a combination of any of an ion conductor, electron conductor or mixed electrical conductor in the chemical reaction part.

2. The chemical reaction system according to Claim 1, wherein interfaces consisting of a metal phase of the electron conduction phase, an oxygen deficient part of the ion conduction phase and micro spaces (gaps) surrounding the contact points of these are formed as the micro reaction regions at the points of contact between the electron conduction phase and the ion conduction phase.

3. The chemical reaction system according to Claim 1, wherein micro reaction regions where the oxidation-reduction reactions take place are introduced into the cathode.

4. The chemical reaction system according to Claim 1, wherein a working electrode layer to manage oxidation-reduction reactions is formed in the upper part of the cathode, and micro reaction regions nanometers to a micrometer in size where the oxidation-reduction reactions take place are introduced into the same layer.

5. The chemical reaction system according to Claim 1, wherein a substance making up all or part of the micro reaction regions has an oxidizing or reducing effect on the target substance.

6. The chemical reaction system according to Claim 1, wherein the metal phase consists of ultrafine particles of a metal phase produced by an oxidation-reduction reaction generated across some or all of an electron conductor or mixed electrical conductor by subjecting the chemical reaction system to current or heat treatment in a reducing atmosphere.

7. The chemical reaction system according to Claim 1, wherein the oxygen deficient part consists of an oxygen deficient layer produced by an oxidation-reduction reaction generated across some or all of an ion conductor or mixed

electrical conductor by subjecting the chemical reaction system to current or heat treatment in a reducing atmosphere.

8. The chemical reaction system according to Claim 1, having a structure in which the ion conductor and electron conductor contact each other in at least one place to constitute the micro reaction regions, or in which they contact each other in the manufacturing process thereof.

9. The chemical reaction system according to Claim 1, wherein a barrier layer of a substance capable of interrupting electron conduction is included on the pathway which the target substance travels from the electrochemical cell surface to the space where the chemical reaction takes place.

10. The chemical reaction system according to Claim 1, wherein the chemical reaction is a conversion reaction of matter or energy.

11. The chemical reaction system according to Claim 1, wherein the target substance is nitrogen oxides.

12. The chemical reaction system according to Claim 10, wherein the chemical reaction is reduction degradation of nitrogen oxides.

13. The chemical reaction system according to Claim 9, wherein a chemical reaction represented by the following general formula:

$$Mox + xe \rightarrow M + x/2O^{2-}$$

$$M \rightarrow xe + M^{x+}$$

(where M is a metal, O is an oxygen atom and e is an electron) is generated in the chemical reaction system.

14. A method for manufacturing the chemical reaction system defined in any of Claims 1 through 13 comprising introducing micro reaction regions where oxidation-reduction reactions of a target substance take place into a chemical reaction part by applying current or heat treatment in a reducing atmosphere to the points of contact between an ion conduction phase and an electron conduction phase composed of a combination of any of an ion conductor, an electron conductor and a mixed electrical conductor in the chemical reaction part.

15. The method according to Claim 14, wherein when the substances contact each other to form an interface, one or both of them is in a reduced state.

16. A method for activating a chemical reaction system, wherein in the chemical reaction system according to Claim 1, pairs are formed of metal phase parts of an electron conduction phase or mixed electrical conduction phase and oxygen deficient parts of an ion conduction phase or mixed electrical conduction phase.

17. A chemical reaction system in which the chemical reaction part is composed of 1) an oxygen ion conductor (ion conduction phase), a corresponding cathode (reduction phase) and anode (oxidation phase) with the ion conduction phase therebetween or 2) an oxidizing and/or reducing catalyst as basic units for performing chemical reactions of a target substance, wherein the chemical reaction part is subjected to current or voltage or to heat treatment in a reducing atmosphere or under reduced pressure to activate the ability to ionize and remove oxygen which impedes reactions when adsorbed by the chemical reaction part.

18. The chemical reaction system according to Claim 17, wherein a chemical reaction part having a reduction layer which has selectively for both oxygen and a target substance, respectively and holes a micrometer or less in size which are necessary for efficiently supplying and processing the target substance in the reduction phase is used as the chemical reaction part.

19. The chemical reaction system according to Claim 17, wherein a chemical reaction part having micro reaction regions where oxidation-reduction reactions of a target substance take place introduced into part of the chemical reaction part by applying current, voltage, or heat treatment in a reducing atmosphere or under reduced pressure

to the points of contact between an ion conduction phase and an electron conduction phase composed of a combination of any of an ion conductor, an electron conductor and a mixed electrical conductor is used as the chemical reaction part.

20. The chemical reaction system according to Claim 19, wherein a chemical reaction part is used in which interfaces consisting of metal parts of the electron conduction phase, oxygen deficient parts of the ion conduction phase and micro spaces (gaps) surrounding the points of contact of these are formed as the micro reaction regions.

21. The chemical reaction system according to Claim 19, wherein a chemical reaction part having micro reaction regions where the oxidation-reduction reactions take place introduced into the cathode is used as the chemical reaction part.

22. The chemical reaction system according to Claim 17, wherein a chemical reaction part having a working electrode layer for managing oxidation-reduction reactions in the upper part of the cathode and micro reaction regions nanometers to a micrometer in size where the oxidation-reduction reactions take place introduced into the same layer is used as the chemical reaction part.

23. The chemical reaction system according to Claim 17, wherein the target substance is nitrogen oxides.

24. The chemical reaction system according to Claim 22, wherein the chemical reaction is reduction degradation of nitrogen oxides.

25. A method for using a chemical reaction system for performing chemical reactions of a target substance defined in any of Claims 17 through 24, comprising maintaining the temperature of the system at 400 to 700°C, or raising or lowering the temperature within this temperature range in the chemical reaction system, and applying current or voltage at intervals of time to activate the chemical reaction part.

26. A method for activating a chemical reaction system for performing chemical reactions of a target substance defined in any of Claims 17 through 24, comprising maintaining the temperature of the system at 400 to 700°C, or raising or lowering the temperature within this temperature range in the chemical reaction system, and applying current or voltage treatment between the cathode and anode for 1 minute to 3 hours.

27. The method for activating a chemical reaction system according to Claim 26, wherein an electrochemical reaction is generated by applying 5 mA to 1 A current or 0.5 V to 2.5 V voltage.

28. The method for activating a chemical reaction system according to Claim 26, wherein current or voltage treatment is performed in an oxygen partial pressure of 0% to 21% (in atmosphere).

29. A method for activating a chemical reaction system for performing chemical reactions of a target substance defined in any of Claims 17 through 24, comprising maintaining the temperature of the system at 500°C or more, or raising or lowering the temperature within this temperature range in the chemical reaction system, and heat treating the system in a reducing atmosphere or under reduced pressure.

30. A reaction method which is an oxidation-reduction reaction method using an oxidation-reduction reactor composed of a solid electrolyte oxygen ion conductor and at least an electrode consisting of an electron conductor, comprising producing the cathode provided with reductant (R) and reduction product AO_{x-y} (where $0<y\leq x$) by an oxidation-reduction reaction of oxide AO_x and reductant (R) based on the reaction formula $AO_x + R \rightarrow RO_y + AO_{x-y}$, or producing the anode provided with oxidant ($R'O_x$) and oxide AO_y by an oxidation-reduction reaction of compound A and oxidant ($R'O_x$) based on the reaction formula $A + R'O_x \rightarrow R'O_{x-y} + AO_y$.

31. The reaction method according to Claim 30, wherein the cathode is provided with a reductant (R) consisting of a metal or suboxide, (1) oxide AO_x (where x is 1/2 the oxidation number of A) is introduced into the reactor and the reduction product AO_{x-y} (where $0<y\leq x$) is produced by an oxidation-reduction reaction of oxide AO_x and reductant (R) based on the reaction formula $AO_x + R \rightarrow RO_y + AO_{x-y}$, and (2) current is supplied to the electrode and the oxidized reductant (RO_y) is reduced by the electrochemical reaction represented by the reaction formulas $y2e^- + RO_y \rightarrow R + yO^{2-}$ (cathode) and $yO^{2-} \rightarrow y\ 1/2\ O_2 \uparrow + y2e^-$ (anode) to restore the reductant (R).

32. The reaction method according to Claim 31, wherein current is supplied to the electrode to restore the reductant (R) either after or simultaneously during production of the reduction product AO_{x-y} (where $0<y\leq x$) by an oxidation-reduction reaction of oxide AO_x and reductant (R).

33. The reaction method according to Claim 32, wherein the reductant (R) is a nitrogen oxide reductant, and a reduction product of N_2 is produced by an oxidation-reduction reaction of the nitrogen oxide reductant and the nitrogen oxide NO_x based on the reaction formula $NO_x + R \rightarrow RO_x + x/2N_2$ to remove the NO_x.

34. The reaction method according to Claim 33, wherein the oxidation-reduction reactor comprises a nitrogen oxide reductant consisting of metals or suboxides 50% or more of which comprises one or more elements selected from Ni, Cu and Fe, an electrode consisting of an electron conductor which is one or more selected from Au, Pt, Ag, Pd, a Ni oxide, a Cu oxide, a Fe oxide and a Mn oxide, and a solid electrolyte oxygen ion conductor consisting of zirconium oxide.

35. The reaction method according to Claim 33 or 34, wherein the size of the nitrogen oxide reductant is 10 nm to 1 μm.

36. The reaction method according to Claim 33, wherein an oxide electron conductor which is one or more selected from a Ni oxide, a Cu oxide, an Fe oxide and a Mn oxide is brought into contact with a solid electrolyte oxygen ion conductor, and cathode current is supplied to the electron conductor to reduce part of the oxide electron conductor and form a nitrogen oxide reductant 10 nm to 1 μm in size.

37. The reaction method according to Claim 30, wherein the anode is provided with an oxidant ($R'O_x$) consisting of an oxide, (1) compound A is introduced into the reactor and oxide AO_y is produced by an oxidation-reduction reaction of compound A and oxidant ($R'O_x$) based on the reaction formula

$A + R'O_x \rightarrow R'O_{x-y} + AO_y$, and (2) current is supplied to the electrode and the reduced oxide $R'O_{x-y}$ is oxidized by the electrochemical reaction represented by the reaction formulas $yO^{2-} + R'O_{x-y} \rightarrow R'O_x + y2e^-$ (anode) and $y2e^- + O_2 \rightarrow y2O^{2-}$ (cathode) to restore the oxidant ($R'O_2$).

38. The reaction method according to Claim 37, wherein current is supplied to the electrode to restore the oxidant ($R'O_x$) either after or simultaneously during production of the oxide AO_y by an oxidation-reduction reaction of compound A and oxidant ($R'O_x$).

39. The reaction method according to Claim 37 or 38, wherein compound a is a hydrocarbon or organochlorine compound.